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METHOD FOR TREATING FLUIDS

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METHOD FOR TREATING FLUIDS

FIELD OF TECHNOLOGY

The present invention relates to a method for treating fluids using ozone and free radicals as treating medium.

BACKGROUND OF THE INVENTION

Ozone has been used for a number of years for treating fluids in order to remove contaminants and impurities. One way to do this is to irradiate the fluid with UV-light containing specific wave-lengths for generating ozone from the oxygen in the fluid. Several methods have been developed in several countries for purifying water with ozone (O_3) in drinking water installations and bathing facilities, and also ozone dissolved in water for cleaning, disinfection and sterilization of articles.

The inactivation of micro-organisms with the aid of ozone and radicals is considered as an oxidation reaction. The membrane of the micro-organism is the first to be attacked. Within the membrane/cell wall, the ozone and the radicals destroy nuclear material inside the cell/virus/spore. The inactivation reaction in the case of most micro-organisms occurs within fractions of seconds, depending on the ozone dose and the amount of free radicals which are formed.

Despite its solubility in cold water, ozone is broken down (=consumed) quickly, as is the case in air, which gives a great many different radicals and more or less stable by-products. The degree of breaking down depends on the pH, the substance which is exposed and the temperature. Certain substances are broken down easily by the ozone. However, the majority of substances and molecules are oxidized more efficiently by free radicals which are formed by ozone and the media treated by ozone.

One very efficient method of using free radicals in the oxidizing process is disclosed in the international patent application No. WO 96/20017. The method utilises UV-radiation to create ozone in air and liquid, which ozone is radiated with certain wave-lengths in order to obtain free radicals, which oxidize the contaminants in the air or liquid. In order to increase the production of free radicals, catalysts are used, for example titanium dioxide. The applicant of the above patent application has obtained very good results in purifying/decontaminating water in cooling towers, swimming pools, green houses, to name a few applications. The use of the patented method has enabled substantial reduction or complete removal of chemicals in those applications. There are of course many other applications in which the above mentioned method us applicable and can perform very good results.

For certain applications however, the above mentioned method has some shortcomings. If the liquid is heavily contaminated, the amount of ozone might not be sufficient to generate the amount of radicals needed for a complete removal of contaminants in the liquid. This may be due to that the radiating energy for creating ozone in the liquid either is absorbed or blocked by the contaminants or other particles/matter in the liquid. In for example treatment of salt water a lot of energy is absorbed by halogens. Thereby not enough ozone is created and thus not enough radicals for the purification process. There might also be the case that the amount of oxygen for creating ozone is insufficient.

In view of the above it would therefore be advantageous to increase the ozone content in a simple and economical way using the radicals as the primary purification oxidants. Regarding the application treating salt or brackish water it would be advantageous to use a continuous system.

BRIEF DESCRIPTION OF THE INVENTION

The present invention aims at providing a method and system for efficient treatment of polluted liquids.

This aim is solved by the method and apparatus according to claim 1 and 5 respectively.

According to a main aspect of the invention it is characterised by a method for treating liquids, comprising the steps of irradiating a flow of air and a flow of the liquid to be treated at the same time in order to create ozone in both the air and the liquid, mixing the ozone-containing air with the liquid to be treated up-streams the liquid irradiating point, irradiating the flow of liquid containing the in-mixed ozone in order to break down the ozone in the liquid for producing free radicals.

According to another aspect of the invention it is characterised in exposing the fluid to at least one catalyst at the same time as the ozone is broken down for increasing the amount of free radicals.

According to a further aspect of the invention, it is characterised in that the mixing is obtained by an ejector effect into the flow of liquid.

The advantages with the present invention are several. By irradiating air and liquid at the same time with the same UV radiating light source ozone is created both in the air and in the liquid, thereby avoiding separate ozone generating sources. The ozone containing air is then fed to the flow of liquid up-streams the irradiating point, whereby among other constituents the ozone is mixed with the liquid to be treated. In this way the ozone in the liquid starts to react with the contaminants to a certain extent. The ozone-containing liquid is then irradiated whereby the ozone created in the liquid and the ozone mixed with the liquid is broken down to form a large amount of free radicals, which perform the main purifying/treating action. In total larger quantities of ozone can be generated/contained in the liquid than if the liquid was only irradiated by the UV light generating means. This is especially true if one compares the oxygen content between for example water and air in that

air contains drastically larger quantities of oxygen than water. Yet the increase of ozone is performed in a simple and effective way without using additional ozone generating means or pre-treatment containers. Because ozone is added, the previous mentioned problem with radiation energy being absorbed/blocked leading to insufficient production of ozone is thereby eliminated. The generating process is simultaneous in that ozone is created by the UV light generating means in both the air surrounding the UV light generating means and in the liquid in the container at the same time as the ozone in the container is broken down to produce radicals.

In order to further increase the amount of radicals, the treatment point, for example a container where the liquid is irradiated, is arranged with catalysts capable of increasing the amount of radicals. The catalysts can consist of titanium dioxide and may be arranged on the inner surface of the container. According to one embodiment the container might be manufactured from titanium, or at least lined with titanium, which is treated in a suitable way to create titanium dioxide. A very large catalytic surface is thus created in a simple and efficient way. Furthermore, the titanium has the advantage to withstand the very corrosive environment inside the container.

The mixing is preferably performed by using a throttle or the like decrease of the inlet section, like for example a Venturi pipe, which is capable of creating a negative pressure, thus creating an ejector effect. No special arrangements or components are thus required for mixing the ozone with the liquid. The amount of the ozone to be mixed can readily be regulated by controlling the air flow passing the UV –light generating means.

These aspects of and advantages with the present invention will become apparent from the following detailed description of the present invention and from the accompanying drawings.

SHORT DESCRIPTION OF THE DRAWINGS

In the detailed description of the present invention reference will be made to the accompanying drawings, of which

Fig. 1 is a schematic side view of one embodiment of the present invention, and

Fig. 2 is a schematic side view of a variant of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows one embodiment of the present invention. It comprises a treatment container 10 having an inlet 12 and an outlet 14 connectable to a transport system for the liquid to be treated. Substantially the whole inner surface is arranged with titanium, either in that the compartment is made of titanium or that the inner surface is arranged with a layer of titanium, which is treated to obtain titanium dioxide for increasing the amount of free radicals produced by the UV radiation. The treatment to obtain titanium dioxide may for example be done by etching the titanium pipe or the layer. The titanium also has the advantage that it is very resistant to the corrosive environment inside the container.

A tube 16 made of quartz glass extends through the interior of the container between two opposite walls 18, 20. Inside the quartz tube a UV radiating light source 21 is arranged, which extends between the opposite walls of the compartment. The light source is connected to a suitable power supply.

At one end of the quartz tube a compartment 22 is arranged, having passages 24 communicating with the interior of the quartz tube. The compartment also is provided with an air intake passage 26, which passage is arranged with a one-way valve 28 admitting only air onto the

compartment. Around the opposite end of the quartz tube a second compartment 30 is arranged. It also is arranged with passages 32 communicating with the interior of the quartz tube.

A conduit 34 is connected to the second compartment. The other end of the conduit is connected to a section 36 of the inflow conduit 38 via a one-way valve 40, which section 36 is arranged with a narrower cross-section like a Venturi tube in order to create a ejector effect around the connection of the conduit, as will be described below.

The device is intended to function as follows. The UV radiating light source is switched on, whereby it is chosen such that it emits wave lengths in the region of 180 – 400 nm, and in particular wavelength of 183.7 nm for converting oxygen in the medium to ozone molecules (O_3) and 254 nm for decomposing the ozone molecules, as will be described.

Air enters the quartz tube through the one-way valve in the first compartment and surrounds the UV generating light source. The irradiation causes the oxygen molecules to be converted to ozone. Since the air flows along almost the entire length of the UV generating light source it is exposed to radiation for a rather long period, ascertaining that a large quantity of ozone is created. At the same time some of the ozone is broken down to free radicals by the radiation wave lengths that decompose the ozone to radicals.

The liquid to be treated is fed through the liquid inlet 12 and into the container 10 surrounding the quartz tube 16. Because of the flow through the throttle section 36 of the flow conduit 38 of a Venturi-type, a negative pressure is created, whereby ozone from inside the quartz tube is drawn into the flow of liquid via the conduit 34 and the one-way valve 40. The liquid that thus enters the container is mixed with ozone.

Further, the irradiation of the liquid in the container will also create ozone by the UV light. Thus the liquid in the container contains both ozone that has been mixed in and ozone that has been created in the container by the irradiation. In the container the liquid is irradiated by the 254 nm wave length which causes the ozone in the liquid to decompose and hydroxyl radicals to be formed. It is a simultaneous generating process in that the UV light generating means generates ozone in the air and in the liquid at the same time as it generates radicals in the liquid. The amount of radicals is further increased by the catalytic properties of the inner wall of the container by the titanium dioxide.

By choosing the proper flow of air through the system the amount of ozone that is mixed with the liquid at the inflow can be regulated in correspondence with the capacity of the UV radiating light source so as to minimize the amount of residual ozone, thereby preventing that ozone leaves the container via the outlet.

Fig. 2 shows a variant of the device of Fig. 1 intended to be used with the modular system described in the Swedish patent application No. 0202987-3, which hereby is incorporated by reference. In this application one section of the device according to Fig. 2 can then replace two inter-connected sections according to 0202987-3. The device according to Fig. 2 can otherwise be connected in many different ways and connected with other parts, both in series and in parallel.

Is to be understood that the embodiments and variants of the present invention are to be regarded only as non-limiting examples of the invention and that it may be modified within the scope of protection defined by the patent claims.

PATENT CLAIMS

1. Method for treating liquids, comprising the steps of
   - irradiating a flow of air and a flow of the liquid to be treated at the same time in order to create ozone in both the air and the liquid,
   - mixing the ozone-containing air with the liquid to be treated upstreams the liquid irradiating point,
   - irradiating the flow of liquid containing the in-mixed ozone in order to break down the ozone in the liquid for producing free radicals.

2. Method according to claim 1, comprising the further step of exposing the fluid to at least one catalyst at the same time as the ozone is broken down for increasing the amount of free radicals.

3. Method according to claim 1 or 2, wherein the UV radiation which is emitted for breaking down the ozone and contaminants has a wavelength of 245 nm - 400 nm.

4. Method according to Claim 3, wherein the UV radiation which is emitted for breaking down the ozone has a wavelength of 254 nm.

5. Method according to any of the preceding claims, wherein the mixing is obtained by an ejector effect into the flow of liquid.

6. Apparatus for treatment of liquid according to claim 1, comprising a container having an inlet and an outlet for the liquid to be treated, UV generating light source capable of irradiating the inside of the container, air guidance means arranged inside the container, connected to an air source and an inlet conduit for the liquid to be treated via a mixing means.

7. Apparatus according to claim 6, wherein said air guidance means comprises a compartment divided from the inside of the container by a quartz glass and that said UV light radiating means is arranged in or adjacent said compartment.

8. Apparatus according to claim 6, wherein substantially the whole of the inner surface is arranged with a catalyst.

9. Apparatus according to claim 8, wherein the catalyst comprises titanium dioxide.

10. Apparatus according to any of the preceding claims 6-9, wherein the mixing means comprises a throttle on the inlet, which throttle is capable of creating an ejector effect of the air/ozone into the flow of liquid.

ABSTRACT

The present invention relates to a method for treating liquids, comprising the steps of irradiating a flow of air and a flow of the liquid to be treated at the same time in order to create ozone in both the air and the liquid, mixing the ozone-containing air with the liquid to be treated up-streams the liquid irradiating point, irradiating the flow of liquid containing the in-mixed ozone in order to break down the ozone in the liquid for producing free radicals. The invention also relates to a device for carrying out the method.

(Fig. 1)

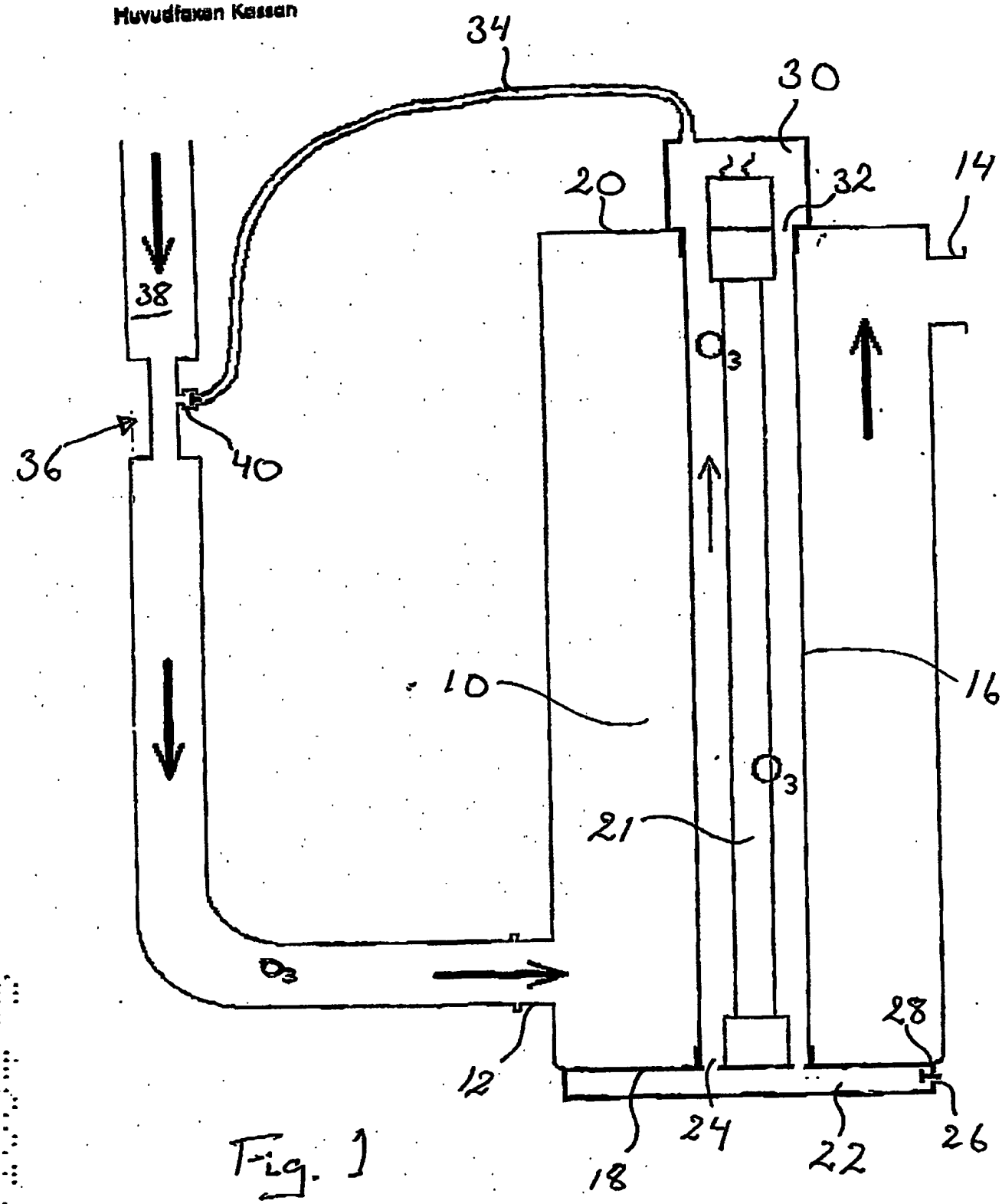

Fig. 1

Fig. 2